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THE RELATION BETWEEN *STREPTOCHETUS SEXCOSTATUS* (BEYRICH, 1856) AND *STREPTOCHETUS ABRUPTUS* (BEYRICH, 1856) (MOLLUSCA, GASTROPODA) (MIOCENE, NORTH SEA BASIN)

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Cadée, M.C., & A.W. Janssen. The relation between *Streptochetus sexcostatus* (Beyrich, 1856) and *Streptochetus abruptus* (Beyrich, 1856) (Mollusca, Gastropoda) (Miocene, North Sea Basin). - Meded. Werkgr. Tert.Kwart.Geol.,vol.20(3):96-104,1 fig.,1 pl.Leiden,September 1983.

Evidence found in the vertical distribution and in the occurrence of a transitional form (*Streptochetus "quinquecostatus"* Rasmussen) indicates that *Streptochetus abruptus* is a younger evolutionary form of *Streptochetus sexcostatus*. The strata in which both species or intermediate forms are present seem to be very restricted in thickness. This observation is a helpful instrument in stratigraphical correlations, as all strata containing *S. abruptus* are necessarily younger than deposits in which *S. sexcostatus* is present. So, the Twistringen Member and parts of the Reinbek and Bokup Members in Northern Germany are apparently younger than the upper shell-bearing parts of the Aalten Member in the Winterswijk area (The Netherlands) and the Dingden Member in the German Lower Rhine area. *S. abruptus* is not restricted to the area North of the so-called "Emsländische Schwelle"; it is also present in the recent boring Broekhuizervorst in the Venlo Graben (The Netherlands). The distribution of both species in this boring and the occurrence of the transitional form fully acknowledge the conclusions mentioned above.

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Contents:

SAMENVATTING

Streptochetus sexcostatus (Beyrich, 1856) en *Streptochetus abruptus* (Beyrich, 1856) zijn als volwassen schelp goed te onderscheiden. Hun onderlinge verwantschap blijkt echter uit het feit dat juveniele exemplaren van beide soorten identiek zijn. Het voorkomen van een vorm met kenmerken van beide soorten (*Streptochetus "quinquecostatus"* Rasmussen) in Hoddemark (Denemarken), Twistringen (BRD) en in de boring Broekhuizervorst (Venlo-slenk), alsmede het voorkomen van *S. abruptus* in laatstgenoemde boring is de aanleiding voor dit artikel.

Voor een intermediaire vorm zijn twee verklaringen mogelijk, n.l. een bastaard van twee tegelijkertijd levende soorten, ofwel een tussenvorm uit een evolutionaire ontwikkeling van de ene soort naar de andere. In het geval van een bastaardvorm zouden beide soorten zich langs aparte "lineages" ontwikkeld moeten hebben, maar *S. abruptus* was tot op heden alleen bekend uit de Twistringer Schichten ten Noorden van de "Emsländische Schwelle" en is, ondanks uitgebreide bemonstering, nooit in het Midden Mioceen van Nederland en België of in het Mioceen ouder dan de Twistringer Schichten van Duitsland gevonden.

Waarnemingen in de kleigroeve te Twistringen en in de boring Broekhuizervorst wijzen er sterk op, dat *S. abruptus* zich uit *S. sexcostatus* ontwikkeld heeft, en dat *S. "quinquecostatus"* een evolutionaire tussenvorm is. Uitgaande van de gelijktijdigheid van deze ontwikkeling in het gehele Noordzeebekken leidt dit tot enkele interessante stratigrafische conclusies.

Het niet voorkomen van *S. abruptus* in het Midden Mioceen van Nederland en België wijst er op, dat deze afzettingen ouder zijn dan het grootste deel van de Twistringen Schichten en de Bokuper Sandstein. Alleen in de boring Broekhuizervorst, waarin een zeer fraaie opvolging van *S. sexcostatus* - *S. "quinquecostatus"* - *S. abruptus* waargenomen werd, komt dus Midden Mioceen van gelijke ouderdom als de Twistringer Schichten voor. Dit heeft als consequentie dat de Astarte radiata Acme Zone van de Afzetting van Aalten niet meer gecorreleerd kan worden met de Reinbeker Schichten, maar ouder dan deze afzetting is, evenals de Spisula sp. Acme Zone en de Limopsis aurita Acme Zone.

De overgangsvorm *S. "quinquecostatus"* Rasmussen is niet geldig beschreven en moet ook niet als een aparte soort worden opgevat. De in het oudere Mioceen voorkomende *Streptochetus abruptus* var. *gottschei* (Gripp, 1914) kan gezien deze waarnemingen géén voorloper zijn van *S. abruptus* en dient als aparte soort, *S. gottschei*, te worden beschouwd.

INTRODUCTION

The two fasciolariid gastropod species *Streptochetus sexcostatus* and *S. abruptus* do not resemble each other very much in their adult forms. Well-developed collabral teleoconch sculpture is present in *S. sexcostatus* on all whorls, whereas this type of ornamentation is restricted to the first two or three whorls in *S. abruptus*, facilitating an easy distinction of the two taxa.

A close relationship of the two forms is demonstrated nevertheless by the fact that juvenile shells consisting of protoconch and first teleoconch whorls cannot be recognized as one of the two.

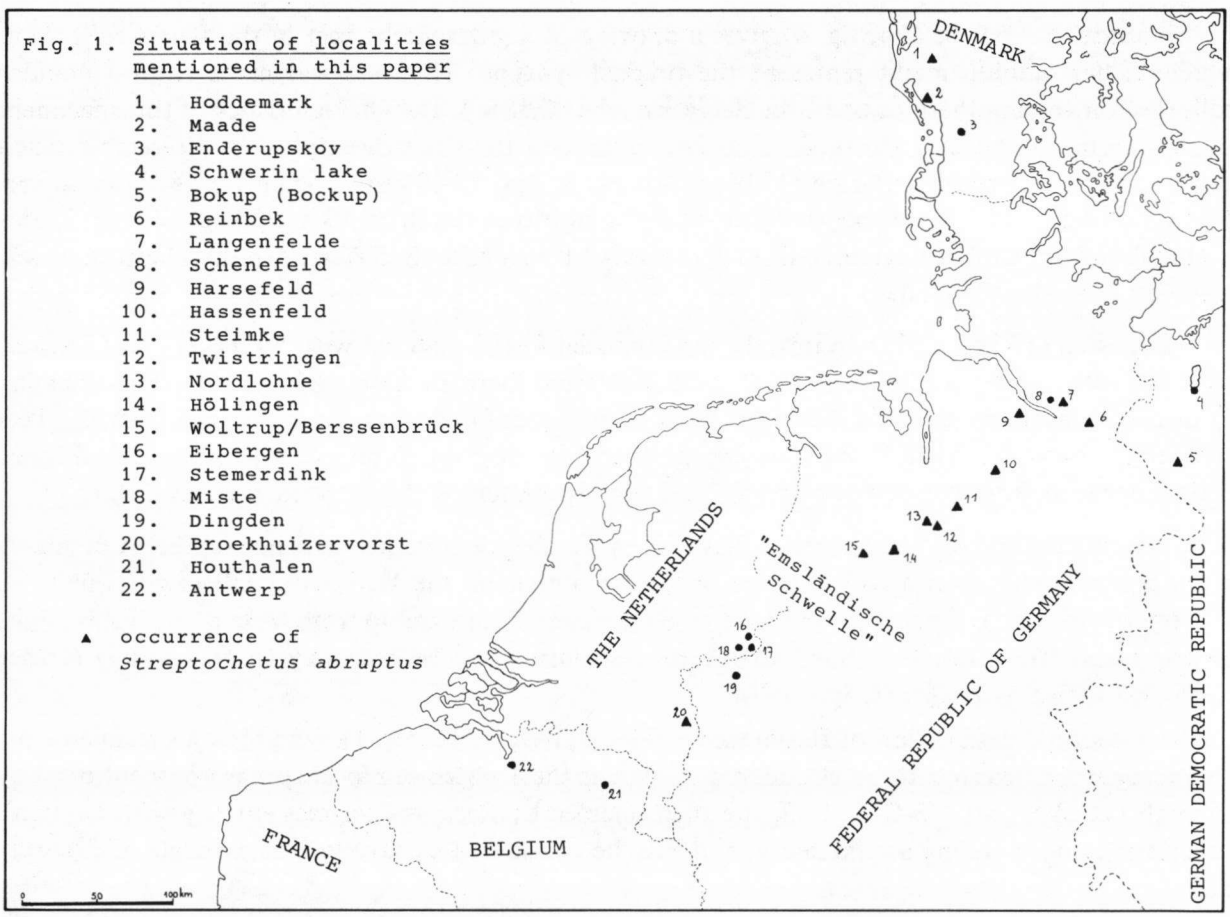
Rasmussen (1968) described a *Streptochetus* form from the Danish Miocene which be indicated as *S. "quinquecostatus"* and considered to be closely related to *S. sexcostatus*. The discovery of specimens identical with this *S. "quinquecostatus"* in the Miocene deposits exposed in de clay-pit

O. Sunder at Twistringen (Lower Saxony, F.R.G.) and in the recently made boring Broekhuizervorst (Venlo Graben, The Netherlands) lead us to a more detailed study of the mutual relationships, resulting in some quite unexpected stratigraphical conclusions.

DEFINITION OF SPECIES, STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION

Streptochetus sexcostatus

This species was based by its author (Beyrich, 1856, p. 287, pl. 24, figs 2a-c, sub nomen *Fuscus sexcostatus*) on specimens from Dingden and Berssenbrück (both Federal Republic of Germany). Beyrich illustrated a defective specimen from Dingden (figs 2a-b), which is presumably kept in the collections of the Paläontologisches Institut in East Berlin. We herewith designate this specimen as the lectotype of *Fusus sexcostatus* Beyrich. In fig. 2c a juvenile specimen is represented, collected at Berssenbrück. The immature condition of this shell, in fact, makes it impossible to identify it as either *S. sexcostatus* or *S. abruptus*.



S. sexcostatus is a widely distributed species in Early and Middle Miocene deposits of the North Sea Basin. It is still present in the Limopsis aurita Acme Zone of the Aalten Member (Stemerdink Bed) (de Vogel, 1970, 1971; Janse & Janssen, 1983) in the Eastern part of the Netherlands and of the Dingden Member of the Lower Rhine area in Western Germany (Anderson, 1964). In the Twistringen Member it is only found in the lowermost parts (see below). The species seems to be

absent in Langenfeldian or younger deposits. We have not been able to find any evidence for the presence of *S. sexcostatus* in the Langenfeldian, as indicated by Anderson (1964, p. 100, table 2). A reported *S. sexcostatus* from the Langenfeldian of Schenefeld (Hinsch, 1973; boring HWW 9, 96-100 m) is probably a *Streptochetus (Streptocarina) klockenhoffi* Hinsch, 1977, a species occurring in Late Langenfeldian and Syltian of NW Germany (Hinsch, 1977, p. 54, pl. 2, figs 9-10).

Streptochetus abruptus

Beyrich (1856, p. 286, no illustration) based his *Fusus abruptus* on two juvenile specimens from Reinbek (Federal Republic of Germany) and adult material in mould preservation from the Bokup (also written as Bockup) Sandstone (German Democratic Republic, see Oehmcke, 1886). The latter material was kept in the Koch collection. Beyrich's collection is in the Paläontologisches Institut in East Berlin, but Tembrock (1965, p. 433) stated that the two juvenile shells from Reinbek are now missing from the Beyrich collection. According to her the Koch collection is kept in the National Museum of Victoria, Melbourne, Austr., but it is unknown to us whether or not the Bokup specimens are still present in this collection.

Tembrock (1965, p. 434, fig. 4) gives a drawing of a guttapercha cast in the Berlin collection, which in her opinion might represent the original syntype. This cast was made from a boulder collected on the Southern coast of the Schwerin lake (G.D.R.). The characteristics of this specimen, as seen from Tembrock's illustration, do not agree with Beyrich's description and resemble much closer a form described by Gripp (1914, p. 21, pl. 2, figs. 17-19) sub nomen *Fusus abruptus* var. *Gottschei*. For this latter form compare also the photographs in Beets (1950, p. 19, pl. 2, figs 9-21). This form differs obviously from *S. abruptus* by an entirely different spiral sculpture; it was recorded from the Vierlandian.

R. Janssen (1979, p. 299) doubtfully synonymized Beets' material with *Streptochetus (Streptolathyrus) ritzkowskii* R. Janssen, 1979, a species from German Late Oligocene deposits. Judging from the illustrations given by Beets we think it highly unlikely that the specimens from the Peel area are conspecific with *S. ritzkowskii*, as there are obvious differences in general shell-form. A final decision, however, has to be postponed until specimens with protoconch are available.

Thus, in our opinion, the specimen pictured by Tembrock certainly does not represent Beyrich's type. If the Bokup specimens should no longer be present in the Melbourne collection (which we will try to find out), a neotype will have to be designated, preferably from Bokup, or, if this might be impossible, from Reinbek. Such a neotype designation will be necessary to prevent any further confusion with *S. gottschei* (Gripp, 1914).

The neotype designation of Rasmussen (1968, p. 149, pl. 16, fig. 1), who took a specimen from Twistringen as such, has to be considered invalid, as the Twistringen locality was not mentioned by Beyrich (I.C.Z.N., art. 75-C-5). Still, the shell selected by Rasmussen agrees entirely with Beyrich's description and, pending a valid neotype, it may be considered a characteristic example of *S. abruptus.*

S. abruptus is known to be a common species in deposits of Reinbekian age, viz. the Reinbeker Schichten and the Bokuper Sandstein, and of the Twistringen Member at Twistringen, Harsefeld, Hassendorf, Steimke, Hölingen, Nordlohne and Woltrup (Anderson, 1964). Furthermore the species is known, in a strikingly thick-set form, from the "Middle Miocene" of Langenfelde (Gripp, 1964, p. 121, pl. 21, fig. 4). Rasmussen (1966, 1968) recorded the species from the so-called "Shell Bed I" in the Danish Hodde Clay (Maade, Hoddemark). Very recently the statement of Anderson (1964,

p. 94), that *S. abruptus* is restricted to the area North of the so-called "Emsländische Schwelle" was found to be incorrect. *S. abruptus* was recognized in samples from the boring Broekhuizervorst (52E.114) in the Peel area (Venlo Graben, The Netherlands). This material, which will be discussed in more detail below, is kept in the collections of the Dutch Geological Survey at Haarlem.

THE STATUS OF *STREPTOCHETUS "QUINQUECOSTATUS"* RASMUSSEN

L. B. Rasmussen (1968, p. 148, pl. 15, figs 1 and 4) conditionally introduced the name *Streptochetus "quinquecostatus"*, based on specimens from the so-called Shell Bed I at Hoddemark, Karlsgårde Canal, a horizon of Reinbekian age in Southern Jylland, Denmark. His description and excellent photographs represent a form with five rather ill-defined collabral ribs per whorl, giving the shell a peculiar pentagonal appearance in apical view. This sculpture is intermediate between *S. sexcostatus*, in which the radial ribs are more numerous and better defined, and *S. abruptus*, where the radial sculpture is restricted to the initial teleoconch whorls. It is impossible to reckon *S. "quinquecostatus"* either to *sexcostatus* or *abruptus*.

According to I.C.Z.N. art. 17-8 *Streptochetus "quinquecostatus"* (conditionally introduced after 1961) is not to be considered a valid taxon.

OBSERVATIONS IN THE TWISTRINGEN CLAY-PITS

In the now-existing clay-pit of the O. Sunder Brickworks at Twistringen (Lower Saxony) a small number of shells were found that match *S. "quinquecostatus"* very closely. This material was collected (by the first author) from the surface of the exposed clays and their exact provenance from the section is unknown therefore. The same sample contains numerous specimens of *S. abruptus*.

At Twistringen *S. sexcostatus* is exclusively found in an assemblage present at the base of the clay section, in the present clay-pit as well as in the former one (Cadée & Janssen, 1968, p. 83-85; Janssen, 1972). This assemblage is characterized by large numbers of the nassariid gastropod *Hinia cimbrica voorthuyseni* Janse & Janssen, 1983. In this community *S. sexcostatus* is a rather common constituent. Neither *S. abruptus* nor *S. "quinquecostatus"* are present here. The upper boundary of this horizon lies at 16.90 m below surface in the section measured by Cadée & Janssen (1968).

The *Hinia cimbrica voorthuyseni* association apparently was absent in a section collected by Hiltermann and studied by Hinsch (1962). Though the sample size was probably restricted (the samples were collected for micropaleontological research) it is obvious from the mollusc fauna that the *Hinia cimbrica voorthuyseni* level was not yet reached. Except for the basal samples *S. abruptus* is regularly present in this section, whereas *S. sexcostatus* was not found.

The few specimens of *S. "quinquecostatus"* from Twistringen are connected with *S. abruptus* by many intermediate forms. It is not known, however, if they occur together in a certain level. It would be very useful to collect a series of sediment samples from short intervals at Twistringen to establish the exact provenance of the *"quinquecostatus"* form. Considering the apparent rarity of this form these samples will have to be quite large, washing and further treatment of the residues will be laboreous and very time-consuming and therefore expensive, which kept us from doing so up to now.

Still, it seems a fair conclusion to accept that at Twistringen *S. sexcostatus* is restricted to deposits below 16.90 m (as described in Cadée & Janssen, 1968) and that *S. abruptus* occurs exclusively in the clays above this level.

OBSERVATIONS IN THE BROEKHUIZERVORST BORING

S. sexcostatus is regularly present in the Broekhuizervorst section in fauna's of Hemmoorian and Reinbekian age. The uppermost sample in which it is found is 157-158 m. The same sample also yielded a distinct specimen of *S. "quinquecostatus"*. A second specimen of this form was found in the sample 156-157 m. Higher residues, up to the sample 151-152 m, yielded typical *abruptus* (see pl. 1).

PLATE 1

Fig. 1. *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856), x 2½.
Twistringen, claypit O. Sunder, below 16.90 m.
Coll. RGM 226.227 (leg. A.W. Janssen, 1975).

Fig. 2. *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856), x 2½.
Twistringen, claypit O. Sunder, depth unknown.
Coll. RGM 226.228 (leg. M.C. Cadée).

Fig. 3. *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856), x 2½.
Twistringen, claypit O. Sunder, depth unknown.
Coll. RGM 226.229 (leg. M.C. Cadée).

Fig. 4. *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856), x 4.
Boring Broekhuizervorst, depth 157-158 m below surface.
Coll. Rijks Geologische Dienst, Haarlem.

Fig. 5. *Streptochetus "quinquecostatus"* Rasmussen, 1968, intermediate form between *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856) and *Streptochetus (Streptodictyon) abruptus* (Beyrich, 1856), x 2½.
Twistringen, claypit O. Sunder, depth unknown.
Coll. RGM 226.230 (leg. M.C. Cadée).

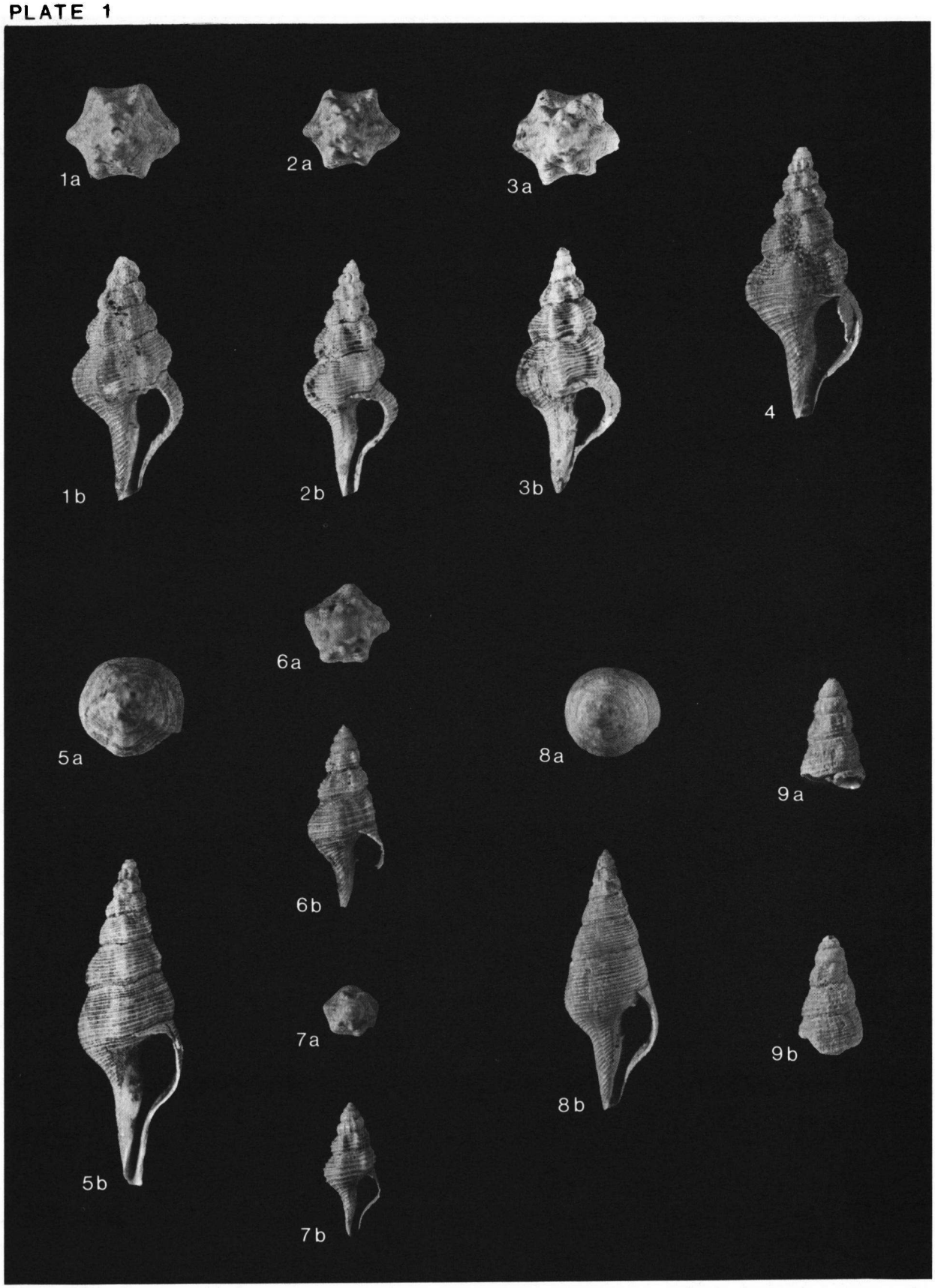
Fig. 6. *Streptochetus "quinquecostatus"* Rasmussen, 1968, intermediate form between *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856) and *Streptochetus (Streptodictyon) abruptus* (Beyrich, 1856), x 4.
Boring Broekhuizervorst, depth 157-158 m below surface.
Coll. Rijks Geologische Dienst, Haarlem.

Fig. 7. *Streptochetus "quinquecostatus"* Rasmussen, 1968, intermediate form between *Streptochetus (Streptodictyon) sexcostatus* (Beyrich, 1856) and *Streptochetus (Streptodictyon) abruptus* (Beyrich, 1856), x 4.
Boring Broekhuizervorst, depth 156-157 m below surface.
Coll. Rijks Geologische Dienst, Haarlem.

Fig. 8. *Streptochetus (Streptodictyon) abruptus* (Beyrich, 1856), x 2½.
Twistringen, claypit O. Sunder, depth unknown.
Coll. RGM 226.231 (leg. M.C. Cadée).

Fig. 9. *Streptochetus (Streptodictyon) abruptus* (Beyrich, 1856), x 4.
Boring Broekhuizervorst, depth 153-154 m below surface.
Coll. Rijks Geologische Dienst, Haarlem.

PLATE 1



INTERPRETATION OF *S. "QUINQUECOSTATUS"*

In our opinion two explanations are possible for the existance of the *S. "quinquecostatus"*-form, viz.

- *"quinquecostatus"* is a hybrid form of *S. sexcostatus* and *S. abruptus*, or
- *"quinquecostatus"* is an evolutionary transitional form between *S. sexcostatus* and *S. abruptus*.

The existance of hybrid forms between *sexcostatus* and *abruptus* seems possible, as these species are apparently closely related; very juvenile specimens are even identical. The occurrence of hybrids, however, would imply that *sexcostatus* and *abruptus* lived contemporaneously, which is contradicted by field observations. Furthermore the co-existance of both species would mean that they have developed along separate lineages.

This latter possibility was implicitly accepted by Tembrock (1965) who regarded the Vierlandian *Fusus abruptus* var. *gottschei* Gripp, 1914 as the forerunner of typical *abruptus*. This would mean that forms of the *abruptus* lineage must have lived during the entire Middle Miocene. Such forms, however, have never been found, in spite of extensive sampling of many North Sea Basin Middle Miocene deposits between the Early Miocene and the Twistringen Member (e.g. Dingden, Stemerdink, Miste, Antwerp, Houthalen). This is certainly not because representatives of the *abruptus* lineage are tied to a special environment. *S. abruptus* is, on the contrary, "facies indifferent" and known from sandy as well as from clayey deposits (Anderson, 1964, p. 94). Therefore we think it highly unlikely that *gottschei* is an earlier evolutionary stage of *S. abruptus*. It should be considered an independant species, *Streptochetus gottschei* (Gripp, 1914); its evolutionary roots may be found in one of the various Late Oligocene *Streptochetus* species.

Much more likely is the hypothesis that *"quinquecostatus"* is a transitional form between *sexcostatus* and *abruptus* and that those species are members of one and the same evolutionary lineage. The transition from the older *sexcostatus* to the younger *abruptus* must have taken place quite suddenly or during a very short time interval. A joint occurrence of these species, if present at all, may be expected in a very restricted stratigraphical interval. This indeed seems to be supported by the observations at Twistringen and in the boring Broekhuizervorst (The Netherlands).

STRATIGRAPHICAL IMPLICATIONS

If we consider the transition of *S. sexcostatus* to *S. abruptus* a basin-wide contemporaneous event, which seems to be a plausible assumption because of the planktotrophic larval shell, this gives us the possibility for several stratigraphical conclusions.

The shell-bearing Middle Miocene (Reinbekian) deposits in the Winterswijk area of the Netherlands and in the Dingden area in Western Germany still contain *S. sexcostatus*. *S. abruptus* has never been found in these areas. Considering *S. abruptus* as the younger evolutionary stage of *S. sexcostatus* is a very satisfying explanation for the absence of *S. abruptus* in these deposits. The Dingdener Glimmerton and the Stemerdink Bed should be correlated at most with the basal part of the Twistringen Member. The upper Twistringen beds with *S. abruptus* are younger and seem to have no equivalent in these areas.

The mollusc fauna from the very top of the Stemerdink Bed is not very well known. This part of the Stemerdink Bed was exposed in the clay-pit Wiegerink at Eibergen, the Netherlands (exposure

34G.3-1 in van den Bosch, Cadée & Janssen, 1975, p. 27, figs 12 and 13, depth 4.80 - 7.55 meters). This clay-pit is no longer accessible, but as far as we know neither *S. sexcostatus* nor *S. abruptus* were found in this exposure. Between the shell-bearing top of the Stemerdink Bed and the overlying barren clays of the Eibergen Member no obvious hiatus is present. May be the lower part of the Eibergen Member, usually considered to be about Langenfeldian in age, is the time equivalent of the Twistringen Member, but this cannot be proven, as the Eibergen Member contains no mollusc fauna.

More to the South, in the Dutch Venlo Graben (boring Broekhuizervorst) equivalents of the Twistringen Member are present again apparently.

In Denmark Shell Bed I at the Karlsgårde Canal (Rasmussen, 1966, p. 100 and 205) near Hoddemark contains *S. sexcostatus* and rarely both *S. "quinquecostatus"* and *S. abruptus*, so the transition from *sexcostatus* to *abruptus* seems to have taken place during deposition of this bed. The overlying Hodde Clay may be considered an equivalent of the upper Twistringen Beds.

According to Anderson (1964) both *S. sexcostatus* and *S. abruptus* are present at the localities Reinbek and Bokup (in fact, Oehmcke, 1866, p. 16, doubted the identification of the only available *sexcostatus* specimen). It can be assumed therefore that the transition of *sexcostatus* to *abruptus* took place before or during deposition of these sediments. The higher parts at least correlate with the Twistringen upper level.

At Twistringen the fauna in the basal sediments, containing large amounts of *Hinia cimbrica voorthuyseni*, indicates deposition in rather deep water (abundance of *Haliris, Pholadomya, Lyonsia* etc.). The higher sediments must have originated in gradually shallower water. These observations agree with the fact that Stemerdink Bed and Dingdener Glimmerton in the Winterswijk-Bocholt area represent the deepest part of a transgressive Middle Miocene sea. The Reinbek as well as the Bokup sediments are deposits from relatively shallow water and fit therefore the general picture.

The opinion of Hinsch (1962) and van den Bosch, Cadée & Janssen (1975, p. 94-95) that the basal part of the Twistringen Member might be of Hemmoorian age is herewith proven to be incorrect. This was already obvious by the fact that the youngest Hemmoorian deposits in this area may be expected to belong to the relatively shallow brachyhaline facies (Oxlundian), as known from extensive parts of northwestern Germany and, may be, also in Denmark (Shell Bed II at Hoddemark and Enderupskov, fide Rasmussen, 1966, p. 200).

Apparently also erroneous is the correlation of the Reinbek Beds with the Astarte radiata Acme Zone of the Aalten Member in the Winterswijk area, as suggested by van den Bosch, Cadée & Janssen (1975). The occurrence of *S. abruptus* in at least the upper part of the Reinbek section indicates an age even younger than the Limopsis aurita Acme Zone. Presumably the similar facies (both are faunas from relatively shallow water) mislead those authors in their conclusion.

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